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RESEARCH PAPER

Assessing the Quality of Seedlings in Small-scale Nurseries in the Highlands of Cameroon: The Use of Growth Characteristics and Quality Thresholds as Indicators

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Abstract In developing countries seedlings are often produced in small-scale nurseries as a means to raise tree planting materials and, provided they are of high quality, these can form the basis for successful forest plantation initiatives. This study uses morphological characteristics to assess the quality of seedlings of three tree species (*Persea americana, Cola acuminata* and *Dacryodes edulis)* in the Western Highlands of Cameroon. The growth characteristics and quality indicators of seedlings produced in two nursery categories were compared—three nurseries collaborating with the tree domestication program implemented by the World Agroforestry Centre (Category 1) and three nurseries collaborating with government and non-governmental projects (Category 2). Seedlings produced in nurseries in the first nursery category were found to be uniform in terms of growth characteristics and quality indicators. In the second category, there were relatively higher seedling proportions having measured parameters out of threshold standards for root to shoot ratio *and* for sturdiness quotient. Significant differences between nursery categories (at $\alpha = 0.05$) were detected in root collar diameter of *C. acuminata* and *D. edulis* and in shoot dry weight of *D. edulis*. These differences could be attributed to better nursery management as a results of training and technical backstopping received by nursery operators in Category 1. The level of experience of nursery operators in both categories was found to be insufficient and greater exposure to skills and knowledge could enhance the production of high quality seedlings.

Keywords Growth parameters · Seedlings quality indicators · Root-to-shoot ratio · Sturdiness quotient · Root deformation · Nursery management

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Introduction

Forest degradation has been attributed to increasing population pressure that has led to an increased demand for more tree products and services and expansion of farming activities (Food and Agriculture Organization of the United Nations (FAO) 1996; Kant and Redantz 1997). The forest area in Cameroon is estimated at about 22 M ha of which 8 M are located in the humid highlands areas and it is assessed that about 200,000 ha of these forest resources are lost annually (Besong and Ngwasiri 1995). Traditionally, trees play a vital role in the livelihoods of small-scale farmers, particularly in developing countries, by providing products and services for household and community use and for sale in local markets (Bawa and Dayanandan 1997). Many of these products have been for decades gathered from various land-use systems including forests. However, in recent years some of these products have entered into the regional and international markets with substantial turnover (Asaah et al. 2011). The inability of these products to continue to provide benefits or the rural poor and address the continuous destruction of the remaining patches of forest has raised much concern among government services and research and development organisations (Harrison et al. 2008; Gregorio et al. 2005).

During the last decade, agroforestry practices in rural areas in Africa have proven to contribute in reducing deforestation and pressure exerted by the small-scale farmers on tree products through the integration of high-value species in various ecosystems (Tchoundjeu et al. 2006). Distinct from other land management systems, agroforestry with its products and services has the advantage of optimizing the trade-offs between farmers' private benefits and those of the global environment (Tchoundjeu et al. 2010; Takoutsing et al. 2012). This recognition has been for more than a decade the main objective of the Participatory Tree Domestication (PTD) program implemented by the World Agroforestry Centre (ICRAF) and its partners in West and Central Africa. The implementation of the program encouraged and supported the establishment of small-scale tree nurseries charged with the responsibility of facilitating the access to improved tree planting materials by rural farmers. Similarly, government and non-governmental organisations through reforestation projects have supported the creation of small-scale nurseries to produce seedlings. The successes of these two categories of nurseries in producing high quality seedlings have not been fully investigated and little information is available about the performances of the seedlings after leaving the nurseries (Degrande et al. 2012).

In the Western Highlands of Cameroon, there are already some nursery operators producing high quality seedlings. However, the majority still produce low quality seedlings that are used for many reforestation projects. This can be generally attributed to nursery operators' lack of basic skills and knowledge in seedling production. The clients of the nurseries are unaware of the seedling quality indicators (Degrande et al. 2012) and generally use height as the main indicator of quality (Grossnickle 1992). Low quality seedlings are sold at low prices in most local markets therefore attracting more buyers than superior seedlings.

The quality of a seedling is expressed through two main aspects, namely the genetic quality or the source of the base materials used and the physical conditions when seedlings leave the nurseries for outplanting (Jaenicke 1999; Wightman et al. 2001).

While improving genetic quality requires a long-term strategy of germplasm selection, improving physical quality can be accomplished in the nurseries. The primary goal of seedling quality assessment is to quantify accurately the levels of morphological attributes of tree seedling that provide potential for vigorous growth and development (Wilson and Jacobs 2006). Inability to recognize seedling quality as a factor of plant performance in the field has led to the failure of many tree planting projects. Strategies for assessing quality of planting stock need to move away from the traditional approach of considering only the height of seedlings (Grossnickle 1992). This growth parameter taken alone often fails to account for differences in seedling characteristics (Gazal and Kubiske 2004; Wilson and Jacobs 2006). No single characteristic determines seedling quality; therefore, seedling quality involves a combination of height, collar diameter, root size, shoot weight and dry weight (Dey and Parker 1997; Jaenicke 1999; Jacobs et al. 2005). Together, these characteristics determine how well the seedling will establish itself once outplanted in the field (Jacobs et al. 2003; Wilson and Jacobs 2006).

Various measurements of morphological characteristics have been developed and used as a tool to predict field performance of tree seedlings and their ability to tolerate mechanical and environmental stresses (Zida et al. 2008; Bayala et al. 2009). However, despite advances in seedling quality testing and prediction of field performance, no single test has proved suitable across a multitude of species and conditions (Davis and Jacobs 2005), indicating that seedling attributes need to be determined at the species level and to take into account specific environmental and management conditions (Zida et al. 2008; Bayala et al. 2009). Testing of seedling quality has not been adopted by most nursery operators in the Western highlands of Cameroon (Degrande et al. 2012). This study uses the morphological characteristics to assess and compare the growth quality indicators of seedlings of three priority tree species namely *Persea americana*, *Cola acuminata* and *Dacryodes edulis*, produced in two categories of nurseries, one collaborating with ICRAF through the PTD Program and the other collaborating with government and non-governmental supported projects.

The Study Area

The study was carried out in Nde and Haut Nkam divisions located in the Western Highlands of Cameroon (Fig. 1). The area lies between latitudes 5°20′ and 7° North and longitudes 9°40′ and 11°10′ East, an area covering 17,910 km^2. The altitude ranges from 300 to 3,000 masl and the annual average rainfall varies between 1,300 and 2,000 mm. The mean daily minimum and maximum temperatures are 15 and 28 °C, respectively. The area is dominated by high volcanic mountains with fertile soils (hydromorphic, volcanic and ferralitic). It is largely an agrarian area with a population estimated at 3.6 million (Minang 2007), the majority (70 %) of whom live in the rural area.

Research Method

A set of seedlings of tree species was selected for analyzing their quality in six nurseries located in sites having similar climatic and soil characteristics. The nurseries

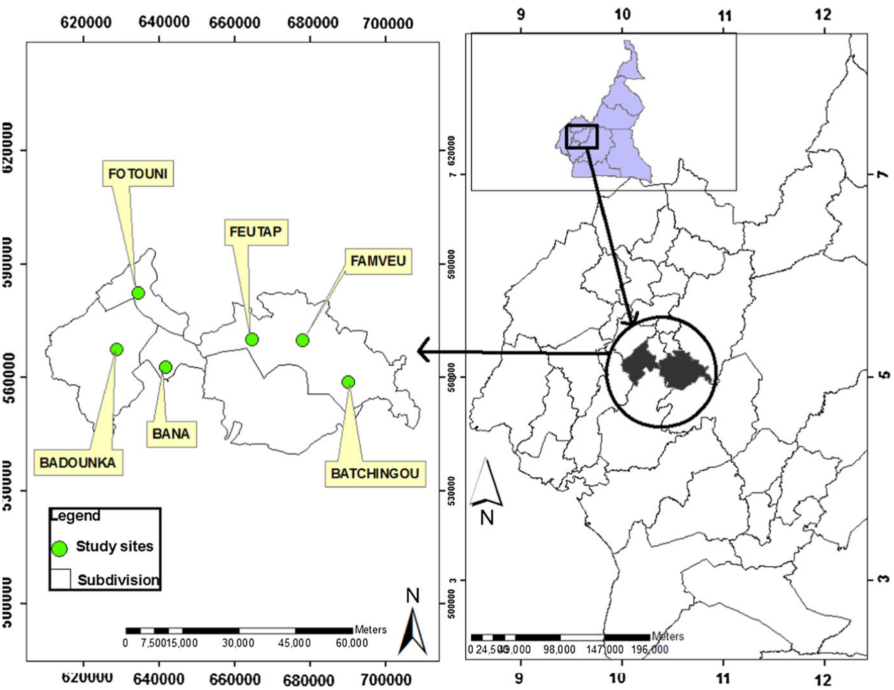

Fig. 1 Map showing the study sites in Cameroon

were divided into two categories of three each. One category has received technical assistance in the form of basic nursery materials, training on nursery establishment and management and technical follow up from ICRAF for at least 5 years. The other category has been collaborating with government and non-governmental organisations for at least 5 years (Table 1). Three species—*P. americana* (pear), *C. acuminata* (kola) and *D. edulis* (plum)—were assessed for quality in each of the nursery. These species are among the priority species selected by farmers in the area through priority setting as recommended by Franzel et al. (1996). Prior to the selection of seedlings, each nursery operator was asked to put together 30 seedlings of the three species that they considered to be of high quality. In each of the chosen nursery, 10 seedlings were randomly selected per species for destructive sampling, to give a total of 30 per nursery and 90 for each nursery category.

The six nurseries selected were all supported with soft-walled black perforated plastic containers measuring 24 × 17 cm to ensure that every single seedling has the same size of growing area. Each nursery operator collected their own seeds of various species and nursed them in seedbeds. In the study area, seeds are collected from standing trees based on operators' chosen-criteria, generally including fruit characteristics and tree production capacity. After the germination, the seedlings were potted with substrate previously prepared by each nursery operator and cared for in the nursery for a period of 5 months. No further technical assistance was given to the selected nurseries during the experimental period.

Table 1 Characteristics of the six selected nurseries

Nursery Collaboration with ICRAF (1)	Date of creation	Nursery No collaboration with ICRAF (2)	Date of creation
Feutap	2004	Badounka	1995
Famveu	2005	Bana	2006
Batchingou	2006	Fotouni	1998

The morphological features used in determining seedling quality were measured for each seedling, including shoot height, root length, root collar diameter, and shoot and root dry weight. The dried weight was determined after the samples had been dried in an oven at 68 °C for 48 h. The instruments used during field data collection were measuring tape or ruler for measuring shoot height and root length (in cm), vernier calipers for measuring root collar diameter (mm), and a sensitive electronic balance for measuring the shoot and root dry weights (gm). The above-ground dry mass was separately measured from root dry mass.

The data on the morphological features of the seedlings were used to compute seedling quality parameters. The *sturdiness quotient* (SQ) refers to the ratio of the height of the seedling to the root collar diameter and expresses the vigour and robustness of the seedling. The ideal value for a seedling to be considered sturdy is less than six (Jaenicke 1999) The *root-shoot ratio* (RS) refers to the proportion of the root dry-weight to the shoot dry-weight and reflects the capacity of the roots to support the above-ground biomass not only for anchorage but also in absorbing water and nutrients from the soil. A high root-shoot ratio indicates high absorption and storage capacity of water, which is of advantage especially in the condition of limited moisture in the soil. A root-shoot ratio between one and two is considered as optimal (Jaenicke 1999). *Root morphology* was assessed visually after the destructive sampling. A deformed root impede the uptake of water and nutrients from the soil and a bent or looped primary root does not provide strong foundation for anchorage of the growing plant, hence making the plant vulnerable to wind throw as it grows older (Harrison et al. 2008).

The data were entered and managed in an Excel spreadsheet. The parameter estimates were then subjected to 2-sample *t* test at a 5 % significance level in GenStat 14.1 for Windows, to compare the two nursery categories. Chi square tests of independence (5 % significance level) were used to assess relationships and seedling proportions between quality criteria (threshold ranges) and nursery categories.

Results and Discussion

Assessment of Seedlings Growth Estimates

The growth estimates of the three species were similar in both categories particularly for seedling height and root dry weight. No significant differences were found for both parameter estimates across the three species (Table 2). However,

Table 2 Growth parameters of seedlings measured on the three species

Growth parameter	Species	Nursery categories compared		*t* test statistics	
		Category 1 (ICRAF)	Category 2 (other nurseries)	t-value	Probability
Seedling height (cm)	*C. acuminata*	61.03 ± 1.753	59.09 ± 2.079	−0.72	0.477
	D. edulis	60.27 ± 1.475	56.69 ± 1.475	−1.72	0.088
	P. americana	63.11 ± 2.405	61.62 ± 2.355	−0.44	0.660
Root collar diameter (mm)	*C. acuminata*	12.23 ± 0.388	10.99 ± 0.344	−2.40	0.020*
	D. edulis	12.16 ± 0.664	10.09 ± 0.638	−2.25	0.028*
	P. americana	12.24 ± 0.472	11.28 ± 0.432	−1.51	0.137
Shoot dry weight (gm)	*C. acuminata*	43.32 ± 2.117	43.82 ± 2.265	0.16	0.873
	D. edulis	32.76 ± 2.205	42.06 ± 2.266	2.94	0.005*
	P. americana	40.92 ± 2.225	42.93 ± 2.222	0.64	0.525
Root dry weight (gm)	*C. acuminata*	29.31 ± 1.474	27.14 ± 1.711	−0.96	0.339
	D. edulis	22.03 ± 1.725	24.93 ± 1.958	1.11	0.271
	P. americana	27.17 ± 1.499	25.30 ± 1.453	−0.90	0.373

Asterisks indicate significance at the 5 % level

significant differences at $p < 0.05$ were detected in root collar diameter of *C. acuminata* ($p = 0.020$) and *D. edulis* ($p = 0.028$) and in shoot dry weight of *D. edulis* ($p = 0.005$). The mean seedling height, root collar diameter and root dry weight in Category 1 were higher than those in Category 2, but their shoot dry weight were lower. Consequently, those in Category 1 can be expected to perform better in the field than those in Category 2. These results are in concordance with those obtained by Mexal and Landis (1990) who found that seedlings with larger stem diameters tend to have higher survival rates and greater growth potential than those having smaller diameters.

Though the seedlings in Category 1 were of higher quality than those in Category 2 in terms of the growth estimates, the above results cannot be conclusive without establishing the link between the growth estimates and the seedling quality indicators assessed in the study.

Assessment of Seedlings Quality Indicators

Root to Shoot Ratio of Seedlings in Nursery Categories

Based on the computed results presented in Table 3, the root to shoot ratio of the three species in both categories of nurseries fit to the general expectations of a balanced root to shoot ratio ($1 < RS < 2$), and no significant differences were detected between the two categories of nurseries at $p < 0.05$. However, a deeper analysis revealed two things; firstly and putting all together, the root to shoot values of the nurseries within Category 1 were similar, while those in Category 2 showed variation in their values implying that seedling in category 1 were generally uniform

Table 3 Seedling quality indicators of seedlings measured on three species

Seedling quality indicators	Species	Nursery categories compared (x ± s.e)		*t* test statistics	
		ICRAF (1)	No ICRAF (2)	t-value	Probability
Root to shoot ratio	*C. acuminata*	1.571 ± 0.104	1.724 ± 0.097	1.08	0.286
	D. edulis	1.578 ± 0.087	1.824 ± 0.094	1.92	0.060
	P. americana	1.556 ± 0.070	1.761 ± 0.080	1.92	0.060
Sturdiness quotient	*C. acuminata*	4.961 ± 0.175	5.335 ± 0.187	1.46	0.150
	D. edulis	4.547 ± 0.217	5.104 ± 0.241	1.72	0.091
	P. americana	5.204 ± 0.171	5.504 ± 0.170	1.24	0.219

in term of root to shoot ratio. Secondly, despite the fact that no significant differences were detected between the two categories of nurseries, the Chi square test (at 5 % significance level) showed a significant relationship (Table 3) between root to shoot ratio class and nursery category for *C. acuminata* ($p = 0.045$), *D. edulis* ($p = 0.002$) and *P. americana* ($p = 0.015$). The percentage of seedlings that have root to shoot ratio values out of the acceptable range (RS > 2) was greater for nurseries in Category 1 than those in Category 2 (Table 4). That is 70.6 % versus 29.4 % for *C. acuminata*, 78.9 % versus 21.1 % for *D. edulis*, and 78.6 % versus 21.4 % for *P. americana*.

These results disguise that even though seedlings of sub-optimal quality were found in both categories of nurseries, those in Category 1 were of uniform attributes, physically of better appearance and consequently of higher quality than those in Category 2 in terms of root to shoot ratio. Nurseries in Category 2 were found to have more seedling with root to shoot ratio values out of the acceptable range (RS > 2) meaning that shoot biomass is too high compared to root biomass. These seedlings are unlikely to withstand the adverse conditions in most planting sites due to inadequate root system that will impede the growth of the plant. The results also substantiate those of Gregorio et al. (2005) who found that seedlings with a low root to shoot ratio ($1 <$ RS < 2) have a greater survival rate than large seedlings with higher root to shoot ratios. Other authors have also emphasized that the production of seedlings with a large, vigorous root system and a root to shoot to ratio to match the needs of the outplanting site is an important factor in successful seedling establishment (McDonald 1991; Barnett and McGilvray 1993; South et al. 2005).

Sturdiness Quotient of Seedlings in Nursery Categories

In general, the sturdiness quotients presented in Table 3 meet expectations in both categories of nurseries, which postulates smaller values than 6 (Jaenicke 1999), and no significant differences were found in mean sturdiness quotient at $p < 0.05$. However, the Chi square test found a significant relationship between sturdiness class and nursery category (with respective p values of 0.032 and 0.001) for *C. acuminata and D. edulis*.

Table 4 Class of root to shoot ratio of seedlings used in the study

Tree species			Collaboration with ICRAF		Total	Chi square tests
			No (2)	Yes (1)		Asymp. sig. (2-sided)
C. acuminata						
Class of root to shoot ratio	>2	Count	12	5	17	0.045
		Relative frequency within class (%)	70.6	29.4	100.0	
	1–2	Count	18	25	43	
		Within class (%)	41.9	58.1	100.0	
D. edulis						
Class of root to shoot ratio	>2	Count	15	4	19	0.002
		Within class (%)	78.9	21.1	100.0	
	1–2	Count	15	26	41	
		Within class (%)	36.6	63.4	100.0	
P. americana						
Class of root to shoot ratio	>2	Count	11	3	14	0.015
		Within class (%)	78.6	21.4	100.0	
	1–2	Count	19	27	46	
		Within class (%)	41.3	58.7	100.0	

The mean sturdiness of the three species revealed lower sturdiness ratio values of the seedlings from Category 1 nurseries than Category 2 nurseries. This was corroborated by 2-sample equality of variance *t* test (at $\alpha = 0.05$) which revealed a significant difference ($p = 0.012$) in overall mean sturdiness between nursery categories; nurseries in Category 1 having a lower overall mean sturdiness (4.909 ± 0.1116) than those in Category 2 (5.314 ± 01164) for nursery (Table 5).

Though the results presented in Table 2 revealed no significant differences between the two categories of nurseries, the percentage of seedlings that have sturdiness values out of the acceptable range ($SQ \geq 6$) is higher in nursery category collaborating with government and non-governmental projects than in nursery category collaborating with the tree domestication program (Table 6). That is 68.2 % versus 31.8 % for *C. acuminata*, 83.3 % versus 16.7 % for *D. edulis*, and 66.7 % versus 33.3 % for *P. americana*. These observations reiterated the fact that seedlings in category 1 have uniform morphological characteristics and are of better quality that those in category 2.

Overall, nurseries in Category 1 (collaboration with ICRAF) exhibit obviously the 'better' results, probably as an outcome of more intensive nursery management. Due to species specific effects, some nurseries could achieve acceptable sturdiness values irrespective of the extent of exposure of nursery operators to improved nursery management techniques. Seedlings with sturdiness ratio greater than six were basically tall, thin and etiolated, while a small quotient indicates sturdy plants

Table 5 Comparison of sturdiness quotient between nursery categories

Nursery category	Size	Mean	Standard error of mean	Difference of means	Standard error of difference	d.f	t-value	Prob.
ICRAF	90	4.904	0.1116	0.410	0.161	178	2.54	0.012
No ICRAF	90	5.314	0.1164					

Table 6 Class of Sturdiness quotient of seedlings of the three species

Tree species			Collaboration with ICRAF		Total	Chi square tests
			No (2)	Yes (1)		Asymp. sig. (2-sided)
C. acuminata						
Sturdiness class	<6	Count	15	23	38	0.032
		Within class (%)	39.5	60.5	100.0	
	≥6	Count	15	7	22	
		Within class (%)	68.2	31.8	100.0	
D. edulis						
Sturdiness class	<6	Count	15	27	42	0.001
		Within class (%)	35.7	64.3	100.0	
	≥6	Count	15	3	18	
		Within class (%)	83.3	16.7	100.0	
P. americana						
Sturdiness class	<6	Count	16	23	39	0.058
		Within class (%)	41.0	59.0	100.0	
	≥6	Count	14	7	21	
		Within class (%)	66.7	33.3	100.0	

with a greater chance of survival, especially on windy or dry sites. Other authors have reported similar results where seedlings with quality indicators out of the acceptable ranges are likely not to perform well once they leave the nursery for on-farms integration (Zida et al. 2008; Bayala et al. 2009; Gregorio et al. 2005).

Prevalence of Root Deformations in Nurseries in Both Categories

Root deformation was observed in both categories of nurseries and with all the species. The most recurrent forms were the J-rooting, twisting and curling that was observed on 30 % of seedling sampled in category 1 and on 65 % of seedlings samples in category 2. Through the destructive sampling and observations made in the nurseries, most of these seedlings were deformed probably as a result of poor nursery management practices and particularly during potting of young seedlings germinated from seedbeds. It was observed that majority of farmers in the study area do not practice root pruning prior to the potting operations. Generally, farmers believe that pruning the tap roots has a negative effect on the growth of the

seedlings and prefer to bend or twist the taproot for it to fit in the polythene bags. These results are alarming considering that bending of the root will not only impair the uptake of water and nutrients from the soil but also will make the plant vulnerable to windthrow as it grows older (Carter 1987; Zida et al. 2008; Bayala et al. 2009; Harrison et al. 2008). This situation has also been observed by Gregorio et al. (2005) in Philippines who found that farmers not exposed to appropriate nursery management usually bend and twist the tap root so that it entire length can be accommodated in the polythene bags.

Root deformations sometimes are attributed to the duration of the seedlings in the nurseries, but for this study, all the seedlings in both categories had the same duration of 5 months. It was also observed that one of the reasons for root deformation is the type of substrate used. While nursery operators in category 1 used substrate blended with organic manure and sand, those in category 2 merely fill the polythene pots with soil materials available around the nurseries. Substrate blended with organic materials and sand is improved in water holding capacity, cation exchange capacity and porosity which are important factors for the development of the seedling rooting systems (Gregorio et al. 2005). The lower percentage of root deformation observed in nurseries in category 1 can be attributed to the exposure of the nursery operators to various trainings on nursery management techniques and technical follow up by ICRAF technicians in the area.

Technical Capacity, Nursery Techniques and Quality Seedling Production

The results of this study were somehow not expected, according to the hypothesis of the study that the characteristics of each single tree species are similar across the respective category of nurseries. However, as there is no communication related to nursery management between the two categories of nurseries, the operators perform according to their experiences and levels of exposure to nursery techniques. So, the growth performance of comparable tree species under observation is more or less a result of the implementation of local expert knowledge for nurseries in category 2 then added to the exposure to improved nursery practices for nurseries in category 1.

In general, it is observed that the nursery operators in both categories have the basic knowledge required to produce seedlings. Most of the operators in category two have gained long-term experiences through trial and errors, while majority of operators in category 1 have gained skills through formal training sessions and technical backstopping from ICRAF. Nevertheless, it is obvious that the experiences of the operators in both categories are insufficient and there still a dearth of knowledge on quality seedling production techniques. Capacity in seedlings production should be a continuous process so as to enhance the combination of nursery techniques with planting site conditions (Byron 2001; Gregorio et al. 2005; Harrison et al. 2008).

Many studies have demonstrated that nursery techniques have a substantial influence on seedling performance after out-planting (Liu et al. 2000; Gao et al. 2007; Wang et al. 2007; Li et al. 2011, 2012; Takoutsing et al. 2012). Most of these studies, however, did not combine nursery techniques with planting site conditions.

Because nursery cultural practices vary by species, nursery environment, and out-planting environment, the only way to fully understand seedling behaviors promoted by nursery techniques and its effectiveness is to consider the conditions of the out-planting site along with the expected seedling performance under those conditions.

Seedling quality has been defined as fitness for purpose. The ideal seedling, suitable for all purposes, does not exist. A target seedling is a plant that has been cultured to survive and grow on a specific out-planting site (Dumroese et al. 2005). In addition, holistic assessment of stock quality requires the integration of both morphological and physiological attributes of seedlings. Consideration of both factors provides a more effective appraisal of the fitness of seedlings for field planting.

Conclusion

Technical support is needed in small-scale nurseries if the production of high quality seedlings is the top priority. The measures introduced by ICRAF in West and Central Africa have proven to be effective in improving the quality of seedlings produced in small-scale nurseries. This improvement has been achieved by providing information in the form of training packages on various nursery management techniques, training manuals and technical notes, and continued technical backstopping. Most nursery operators collaborating with government and non-governmental project have not been exposed to such opportunities, and produce seedlings to meet their own established quality requirement that have nothing to do with physical and genetic qualities required for optimal plant development on farms. It is expected that systematic assessment of the quality of seedling produced by the various nurseries will enhance understanding of the factors which lead to success and failure, and improve and develop good nursery practices for nursery operators.

Policy Implications

High quality seedlings form the basis for any successful tree planting project whether initiated by government, non-governmental organisations or research institutions. Consequently, it is primordial that emphasis be laid on the use of high quality planting materials taking into consideration the level of investment of such initiatives. This can only be implemented if (1) suitable regulations are put in place to guide all reforestation projects as well as private initiatives to procure only seedlings from registered and accredited nurseries that produce high quality seedlings, and (2) an awareness campaign is put in place to sensitize and educate the general public particularly the nursery clients and tree planting project managers on the importance of using high quality seedlings and to stimulate the improvement of nursery seedling production. This will definitely create greater demand for quality seedlings. The production of low quality seedlings is sometimes attributed to low financial potential of the nursery operators. Materials and financial support are needed for the improvement of nursery facilities and management. Clonal orchards

and seed banks will also be of great help to the operators for the continuous collection of germplasm.

In the absence of regulation, there is a lack of quality control in the seedling nursery sector as the markets is supplied with materials from various types of nurseries (government, private, community, individual and research) without any standard and in the absence of any coordination. The present study has proven that nurseries exposed to basic techniques can produce high quality seedlings compared to those that rely on their personal know-how. There is an urgent need to organise the seedling sector in Cameroon and put in place a policy that governs the production of high quality seedlings. This policy should be implemented together with appropriate support to nursery operators in terms of materials and technical skills.

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